General Education Assessment
Quantitative and Technical Reasoning

I. Assessment

The General Education University Requirements include "a 4-5 unit laboratory science designated GL"1. Many UW-W students choose BIOLOGY 120, Biological Foundations, to fulfill this requirement. We developed a set of multiple choice questions based on short readings that appear on all BIOLOGY 120 final exams. These questions test student understanding of 3 critical areas of modern biology: 1) the scientific method, 2) basic Mendelian genetics, and 3) evolutionary theory. The questions are found in Attachment A.

II. Justification

The assessment procedure chosen is one that is commonly used in educational assessment and is also common at UW-W. The students will therefore be familiar with the form and the results will more reliably reflect student learning in the class. The BIO 120 assessment team determined that common coverage of 3 topics in biology was possible no matter what sort of exam each instructor of BIO 120 preferred. The team chose the above 3 areas for the following reasons:

A. Scientific Method: Science differs from other academic disciplines because only empirical data can be used in the testing of scientific hypotheses. The tests must be carefully constructed to minimize a researcher's biases and incorporate appropriate statistical sampling techniques. US citizens are bombarded with a plethora of information that claims to be scientific. It seemed important to us that students learn discern well-designed tests from poorly designed tests and mere conjecture. With this skill they can more effectively evaluate the information they are receiving and make decisions based on information that has been tested scientifically, if they choose. This ability to discern properly tested information could mean the difference between life and death, particularly when it involves medical treatment or environmental claims. Assessment of this area is the most direct, requiring only an understanding of the method and terminology.

B. Genetics: There is no question that genetics has become an essential part of modern life. We chose a simple Mendelian cross as our evaluation tool because it requires a good understanding of chromosomes, gene function, and inheritance patterns. These understandings will be essential in interpreting medical genetics and lifestyle risks in the future. Assessment of this area requires an understanding of ideas and terminology, but also requires the ability to think analytically and the use of some simple analytical tools to produce numerical predictions.

C. Evolution: Modern Biology rests on evolution. Modern systematics, the study of the relationships between species, relies on evolutionary principles to elucidate those relationships. Ecological relationships that develop over long periods of time also are based on the evolutionary principles of inheritance and natural selection. We tested students' understanding of evolutionary principles and terminology, and their ability to reason about the development of an ecological relationship that has medical relevance. These questions rely on the student's ability to synthesize ideas from evolution, ecology and genetics to answer all correctly.

[1] UW-W Undergraduate Catalog 2004-2006, page 51.

Attachment A

BIO 120 Assessment Questions

Reading Problems

I. Scientific Method:

Bluegill sunfish males build mating areas on lake bottoms by clearing sand and gravel, then inviting female to lay their eggs in the "nest". The nest-building male then fertilizes and defends the eggs and just-hatched fish (called "fry"). About 20% of bluegill males do not display this mating behavior, but instead hide near the nest of another male, wait until females lay their eggs into the nest, then rush in and fertilize as many eggs as they can before the nest owning male can drive them off. Bryan Neff of the University of Western Ontario showed that male bluegill sunfish could recognize their own offspring by smell. Dr. Neff decided to test whether nesting males would defend their nests full of fry with less ferocity if some of the fry were not their offspring (such as those who were

the offspring of a male that dashed in at the last minute to fertilize the eggs). He used 2 groups of nesting sunfish males: Group 1 went through the mating cycle without eggs fertilized by another male getting into their nest before the eggs hatched. Group 2 had the same number of eggs as Group 1 but 1/3 of their eggs was swapped for another males eggs. After the eggs hatched, he exposed all of the bluegill males' nests to models of pumpkinseed sunfish that eat fry. He measured the frequency and intensity of the males' defense of the fry. He found that males with 1/3 of their fry swapped for the offspring of another male (Group 2) defended their offspring less frequently and with less intensity than males defending all of their own offspring (Group 1).

1. Which of the following correctly states Dr. Neff's hypothesis?

    a. Female bluegill are attracted to nesting males.

    b. Pumpkinseed sunfish will eat bluegill eggs.

    c. Bluegill males who hide and sneak in to fertilize eggs are more fit than nesting males.

    d. Bluegill males will defend a nest of their own fry more than a nest that includes another male's fry.

2. The control group in Dr. Neff's experiment is

    a. Group 1

    b. Group 2

    c. Both Groups 1 and 2

    d. Neither Group 1 nor 2

3. Dr. Neff's hypothesis was

    a. Supported because females were attracted to nesting males

    b. Not supported because Group 1 defended their nests more vigorously than Group 2

    c. Supported because Group 1 defended their nests more vigorously than Group 2

    d. Not supported because Group 2 defended their nests.

II. Dragonfly Genetics:

A species of dragonflies has two different color varieties. One color is blue and the other is an emerald green. The blue color (B) is dominant over the green color (b). We will cross a heterozygous blue dragonfly with a green dragonfly. With this information, answer the following questions.

1. What is the proper term for the physical expression of the gene?
    a. genotype
    b. karyoke
    c. phenotype
    d. characteristics
    e. personality

2. What is the genetic makeup of green dragonflies?
    a. Some Bb, some BB
    b. All BB
    c. All Bb
    d. Some Bb, some bb
    e. All bb

3. What is the genotypic frequency of the outcome of the proposed cross?
    a. 50% Bb
    b. 100% Bb
    c. 100% bb
    d. 50% BB
    e. cannot be determined

4. What will the offspring look like?
    a. All Green
    b. All Blue
    c. ½ Blue, ½ Green

d. ¾ Green, ¼ blue

III. Antibiotic Evolution

Since the 1940's antibiotics have been widely used for everything from fighting infections to helping increase the weight of cattle. Recently, health workers have found that strains of bacteria that at one time were susceptible to antibiotics have become resistant to many classes of antibiotics. Diseases such as tuberculosis and gonorrhea that were under control and treatable are making a comeback. Research shows that there are a number of different types of resistance to various antibiotics. For example, some bacteria in a population might have enzymes that destroy the antibiotic penicillin while others of the population do not. Some bacteria might have a ribosome that differs slightly in shape than most of the bacteria of a population and therefore be resistant to streptomycin. Some antibiotics work by breaking down the cell wall of bacteria. If some of the bacteria in a population have a slightly different structure in their cell wall then they would be resistant to that class of antibiotics. This variation among individuals of a population= allows some to survive while others are killed. Since the shape of the cell wall or the presence or absence of the penicillin-destroying enzyme is genetically controlled, the daughter cells of the resistant bacteria will also be resistant. The improper use of antibiotics frequently leads to an increase in the number of resistant bacteria in patients. For example, if a patient takes antibiotics to fight an infection but decides to stop the medication when he feels better instead of taking the entire prescription, he may experience a relapse of the infection. But this time the infection is resistant to the antibiotic.

1. An increase in the number of bacteria that are resistant to antibiotics is due to:
    a. Random genetic drift
    b. Natural selection
    c. Hardy Weinberg
    d. none of the above

In nature many types of bacteria, fungus and other organisms compete. The antibiotics we use are actually derived from these organisms. One type of organism will develop the antibiotic the other will develop a counter measure.

2. This is known as

a. co-evolution

b. selection of the fittest

c. selective advantage

d. stabilizing selection

3. For evolution of resistance to occur in bacteria, which of the following factors would be necessary?

a. There must be resistant bacteria in the population.

b. The bacteria must be exposed to new factors in the environment to cause a change in their cell walls.

c. Bacteria species must differ from each other.

d. Cell wall structure must be determined by environmental conditions.